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THE STATE OF WYOMING

GEOLOGIST'S OFFICE

BULLETIN No. 12

LIGHT OIL FIELDS OF WYOMING

BY
L. W. TRUMBULL, STATE GEOLOGIST

(SECOND EDITION)

CHEYENNE, WYO.
THE S. A. BRISTOL CO., PRINTERS AND BINDERS
1916

INTRODUCTION TO SECOND EDITION

The steady large demand for information regarding Wyoming oil fields has so quickly depleted the first edition of this pamphlet that it has seemed best to reprint. The only changes in the pamphlet are the addition of some foot-notes and part of the paragraph under the heading "Depth", with the sketch and tabulation on Pages 128 and 129.

The office is now unable to supply many of the detailed reports which have been issued in years past. Several new reports will issue during the coming winter.

L. W. TRUMBULL,
State Geologist.

Cheyenne, Wyoming.
October, 1916.

Light Oil Fields of Wyoming

While Wyoming has low gravity oils in both older and younger rocks, it is the purpose in this paper to discuss only the light oil fields in strata of Cretaceous age.

These fields are now of prime importance from the fact that the oils are very high in gasoline content (43 to 48 degrees Baume) and free from asphalt or sulphur. The crude oil is frequently used in automobile engines, and, as early as 1883, was used in lamps. By using the motor spirit process of refining the residue from the skimming plants, practically 100 per cent. of the crude is marketed as gasoline, water white, or coke.

While, due to economic reasons, Wyoming has been an oil producer for only a few years, the oil springs and seepages, and even favorable geologic structures, have been known for a long time. The records of the earliest explorers mention the oil springs, which were known to the Indians and from which the oil was gathered by them for medicinal purposes.

GEOGRAPHY

Geographically, nearly every part of the State has oil or gas showings, and while many of these are not economic, the evidence is conclusive that the oil horizon was, at one time, a continuous sheet over the whole State, and, where still present, may be expected to be an oil producer under favorable structural conditions.

Before taking up the geology, it may be well to enumerate the known production, seepages, and showings in wells, and locate them geographically. For this purpose the accompanying map is given. This includes portions of adjoining States as well, for the reason that oil from the same geologic horizon is found in these States at the various points as shown. The following tabulation gives the location by county, and the evidence of oil or gas, as well as the structure of each area. The first six fields are the present producers of the State.* The numbers are the key to the map. (Opposite page 126.)

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*Also, Numbers 22, 26 and 27 became producers during 1916.

CRETACEOUS OIL AND GAS FIELDS IN WYOMING

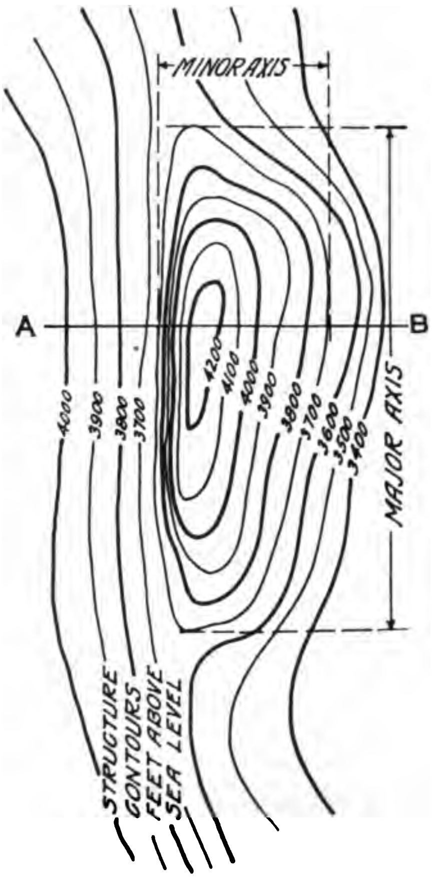
	Name	County	Evidence	Structure	Notes
1	Spring Valley	Uinta	Oil wells	Faulted anticline	Production kept small refinery running for several years.
2	Salt Creek	Natrona	Oil wells	Dome	State Geologist's Bulletin No. 8. Production 5,000,000 barrels per year.
3	Grass Creek	Hot Springs	Oil wells	Dome and cross-faulted plunging anticline	State Geol. Bull. No. 11. Producing.
4	Basin (Torchlight)	Big Horn	Oil and gas wells	Dome	State Geol. Bull. No. 10. Producing.
5	Greybull	Big Horn	Oil and gas wells	Dome	State Geol. Bull. No. 10. Producing.
6	Byron	Big Horn	Oil and gas wells	Dome	Supplies crude for Cowley refinery.
7	LaBarge	Lincoln	Springs	Faulted (?) anticline	Has never been intelligently prospected.
8	Vermillion	Sweetwater	Seepage	Outcrop	Of geologic interest only.
9	Rawlins	Carbon	Oil and gas in wells (not economic)	Plunging anticline	Small amounts of oil and gas at 3450 feet in 1915.
10	Laramie Plains	Albany	Oil and gas in wells (not economic)	Plunging anticline	Showings in shallow wells 1914 and 1915
11	Douglas	Converse	Oil and gas wells	Tertiary over beveled outcrop.	U. S. G. S. Bull. No. 541-C. No production.
12	Oil Mountain	Natrona	Springs and seepages	Anticline	Drilled, 1912. Water.
13	Rattlesnake Mts.	Natrona	Springs and seepages	Outcropping monocline	Much prospected in early days.
14	Washakie	Fremont	Spring and oil wells	Dome on anticline	Fractured and eroded into Mowry shale
15	Newcastle	Weston	Seepages	Monocline	Several dry wells.
16	Moorcroft	Crook	Springs and wells	Outcrop eroded dome	U. S. G. S. Bull. No. 581-C. No production.
17	Bonanza	Big Horn	Springs	Plunging anticline	Well in '90s plugged and abandoned.

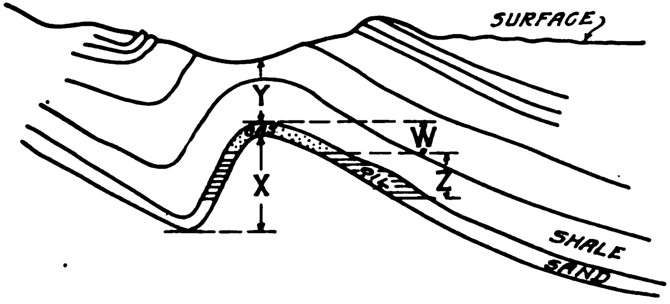
CRETACEOUS OIL AND GAS FIELDS IN WYOMING—*Concluded*

	NAME	COUNTY	EVIDENCE	STRUCTURE	NOTES
18	Buffalo Basin	Park	Gas wells	Dome	Wells of 20,000,000 feet per day.
19	Sunshine	Park	Spring	Eroded anticline	Flowed up till 1910.
20	Oregon Basin	Park	Gas wells	Dome	Very heavy gas flow.
21	Cody	Park	Oil in wells	Narrow anticline	Shallow wells drilled several years ago. show little oil.
22	Big Muddy	Natrona	Oil in well	Broad flat anticline	Shallow shale oil in 1915.
23	Shannon	Natrona	Oil in well	Outcrop	Small amount of heavy paraffine oil free of gasoline.
24	Cottonwood	Washakie	Spring	Faults in slight dome	Globules heavy oil in water springs.
25	Bitter Creek	Sweetwater	Spring	(?)	Reported globules heavy oil in water springs years ago. Now dry.
26	Elk Basin	Park	Flowing wells	Dome	Drilled Fall of 1915.
27	Pilot Butte	Fremont	Wells	Dome	Possible production
28	Alkali Butte	Fremont	Springs and holes	Outcrop of monocline	Eroded below the Dakota
29	Dry Piney	Lincoln	Wells	Dome	Oil at shallow depth
30	Rock Springs	Sweetwater	Gas wells	Dome	Two gas sands at about 1800 ft. depth.
31	Lost Soldier	Carbon	Wells	Dome	Oil under pressure at 350 ft. depth.
32	Wheeler	Natrona		Dome	Drilling for Shannon sand October 1916
33	Pine Mountain	Natrona	Wells	Dome	Drill found gas and small amount oil.

Cretaceous Oil and Gas Fields in Wyoming—*Concluded*

Name	County	Evidence	Structure	Notes





CROSS SECTION ALONG A-B.

SKETCH No 1 — IDEAL DOME.

DEFINING COLUMN HEADINGS USED
IN ACCOMPANYING TABULATION.

X = HEIGHT OF DOME.
Y = DEPTH OF SAND.
W = VERTICAL THICKNESS OF GAS.
Z = VERTICAL THICKNESS OF OIL.

Name of Dome	Major Axis (Miles)	Minor Axis (Miles)	Dip of Limbs	Altitude of sands at crest	Altitude of lowest closing contour	Height of Dome	Depth of Sands	Thickness of Gas Body	Thickness of Oil Body	Remarks
Salt Creek	13	5	20 & 8	4100	2800	1300	900	None	500	
Teapot	4	1½	10 & 4	3300	3000	300	2000	Not drilled		Part of Salt Creek anticline
Grass Creek	8	3	50 & 12	5300	2500	2800	900	None	600	
Buffalo Basin	7	4	40 & 15	4900	3000	1900	1700	Exceeds 500	Not drilled	
Torchlight	5	3	15 & 7	2900	2300	600	400	Slight	200	
Lamb	3	1	6	2700	2600	100	600	100	Slight	Part of Torchlight anticline
Oregon Basin	8 (?)	3 (?)		4700			1000	Not known	None	In Dakota sands
Garland	10 (?)	3 (?)		2300			1700	Not known	None	In Dakota sands
Byron	3 (?)	1 (?)		2100			1900	Not known	None	Secondary dome on Garland uplift
Elk Basin	4 (?)	2 (?)		3400			900	None	Not known	Not surveyed
Big Muddy	6 (?)	1 (?)	Very low	2400 (?)	2200 (?)	200 (?)	2800 (?)	Not drilled		Shale oil at 940 feet
Greybull	4	2	10 & 4	3100	2800	300	800	Blown off	300	Complicated by faults

GEOLOGY

As Wyoming occupied nearly the center of the Cretaceous sea, her whole area was at one time covered with the deep sea muds, which were later consolidated into our present day shales. When the mountain ranges bulged up from the sea bottom at the close of the Cretaceous, many secondary folds, anticlines, and domes were also formed. These invariably follow the rule that their major axis parallels the nearest mountain range and the more steeply dipping limb faces that range. During Tertiary time, erosion cut almost all the Cretaceous rocks, and, in fact, most of all the stratified rocks, from the mountain ranges, and scattered the debris over the intervening valleys and adjoining plains. In some cases, the anticlines and domes were also eroded to the bottom of the Cretaceous strata, in others the Cretaceous is almost intact, and probably there are others now covered by the Tertiary mantle, which are practically not eroded at all.

STRUCTURE

We have, then, at the present time, Cretaceous shales and their interstratified sandstones occurring under the following various conditions:

(1) As outcrops surrounding the mountain uplifts.

(2) As outcrops along anticlines, both faulted and unbroken.

(3) As arches and domes under younger strata.

(4) As deeply covered strata in synclines between mountain ranges, anticlines, and domes.

(*The word dome is here used to mean not only a widening and arching along an anticline, but the equivalent of the old word, "quaquaversal", an arching in all directions, so that the major and minor axes are practically equal in length.*)

Up to the present time, the only producing fields in Wyoming are those in which Nature had prepared a perfect water trap, *i. e.* the non-eroded dome or a sealed fault on an anticline. While heavy asphaltic oils do seal up an outcropping sand, so that oil under pressure will accumulate down the dip, it is certain that the light paraffine-base oils of the Cretaceous do not. This explains why every attempt at finding oil down the dip from an outcrop, or along a plunging anticline, has been a failure.

No commercial field has yet been found in a lenticular sand,* such as are so frequently productive in California. Whether this is due to their absence, or that chance has never placed a well properly to prove their presence, is a question yet to be answered. Equally true, no terrace structure or anticline of very low dips,* such as are productive in Oklahoma, has been proven a producer in Wyoming. It seems, perhaps, needless to say that the sandstones in synclines are invariably filled with water, yet wells are frequently drilled in synclines in spite of the great number of artesian water flows that are present throughout the State as a result of drilling in such structure.

DEPTH

The tabulation on page 129 gives the depth to the most productive sand on the several more important fields. On several of the fields there are more than one productive sand. Grass Creek, for instance, is producing from five, or possibly seven, different sandstones. For several years geologists have been recommending that the lower Colorado sands of the Salt Creek field be tested out. This season (1916) a well which passed through water in the producing (Wall Creek) sand was carried down to the second sand and came in with a good initial production. There is still one more untested sand in this field, which may reasonably be expected to prove productive. The proving of the second sand in Salt Creek is probably the most important item of oil news in the State this year.

The finding of commercial quantities of oil at high geological horizons at Big Muddy, Pilot Butte, Lost Soldier, and Dry Piney makes it seem necessary that we somewhat revise our ideas of what horizons and depths should be prospected, where favorable structure is present. For instance, with the proving of oil in the Shannon horizon at Big Muddy, in addition to the long known oil soaked outcrop of the Shannon sand about Salt Creek, the chances of finding oil or gas in the Shannon in the Wheeler dome are most favorable. The Wall Creek, due to its great depth, has not been attractive to drillers.

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*Big Muddy is an exception. Oil occurs here along the terrace edge and probably is reservoired in lenticular sands in the sandy shale which seems to here represent the Shannon sandstone of Salt Creek fifty miles to the north.

The finding of oil under pressure at only 350 feet depth, and in so high a horizon, at Lost Soldier, was a surprise. Its meaning and commercial importance are as yet undetermined. At Big Piney oil was found at even less depth, but not under pressure. As this area has not been segregated by the United States, as has been the La Barge field lying to the south along the same anticline, it will be tested out this year. The structure is good, but depth to possible reservoir sandstones is unknown. The drilling of deep holes at Oregon Basin, Buffalo Basin, and Rock Springs to test the possibilities for oil in sands below the gas-bearing upper sands is of great interest to the State, but results cannot be known till some time in the future.

Not in every case where the structure is ideal is it possible to drill the great thickness of rocks between the surface and the oil horizon. Failures due to this condition are always due to the lack of knowledge of the depth. In most cases, an error of this sort is inexcusable, for the thickness of the various members is now known for nearly every part of the State and the dips of outcrops are usually easily measured.

QUALITY OF OIL

From present evidence it would seem that depth, or cover of shale, is one factor controlling the condition of the reservoired hydrocarbons; that is, whether oil or gas, or both, or neither, are now present in the crown of a dome. Buffalo Basin has, in the four wells drilled, produced only gas. Depth about eighteen hundred feet. Rock pressure about six hundred and forty pounds. No surface evidences, seepages, wax films in fault planes, gas escapes, etc., etc., have ever been found. Salt Creek, Grass Creek and Elk Basin, with about nine hundred feet of cover, contain oil pools with very little gas. The pools from which the gas has been able to escape generally show evidences of such leakage on the surface.

In every case where the oil comes from depth and under conditions which have not permitted the volatilization of the lighter hydro-carbons, the oil is very high gravity. To believe that the origin is the same, one has but to compare oils from Spring Valley, Washakie Springs, Grass Creek, and Torchlight Dome at Basin. These last three have held the light hydro-carbons in solution to the extent of saturation under atmospheric pressure.

Other fields show heavier oils according to the extent of the volatilization which has taken place. Salt Creek oil is but slightly heavier. Erosion had progressed on that dome to a depth where oil was flowing from faults and cracks in the shale. The gas cap which probably filled a large part of the dome at one time had all escaped. At Moorcroft, Douglas, and in the Shannon sand above Salt Creek are found oils which are almost gasoline-free, so far has volatilization (from the outcrops) progressed. On the Laramie Plains, the drill rope was daubed with heavy, yellow oil after the drill passed through the sand. At various places* on the surface in dome structure a hard paraffine, or ozocerite, is found in small fault planes or in the bedding planes of shales, showing where former leakages from underlying oil pools have dried up to such an extent that only solid matter is left.

It is frequently the case that an outcrop of a once saturated sandstone will show no evidence of former saturation. The oil volatilizes so completely that practically no trace of it is left in a high dry outcrop. Where protected, or under water, as where crossed by a stream, one usually can see evidence of oil. The chloroform test will frequently show a little practically colorless paraffine, but not under all conditions.

These characteristics of Wyoming's Cretaceous oil, that of almost complete evaporation, so that no evidence of it is left to guide the geologist, and its entire lack of ability to seal an outcropping sand, have caused many of the serious errors made by geologists and oil men not acquainted with these peculiarities.

POSSIBILITIES OF NEW FIELDS

The number of unprospected perfect structures remaining in the State is small. At the time of writing, drilling operations have begun on two* seemingly ideal dome structures. By the time this appears in print, we shall probably know whether they contain oil or gas or neither. Up to the present time every perfect structure drilled has proved to be a reservoir. Should oil in paying quantity ever be found in structural terrace, plunging anticline, or behind an outcrop, we will then have to prospect hundreds of such possibilities, but as many such have already been drilled and have been, without exception, failures, it is foolish to be very hopeful of ever getting much production from them.

*Rock Springs has several gas wells and Pilot Butte is now producing oil.

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